

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
9 October 2003 (09.10.2003)

PCT

(10) International Publication Number  
**WO 03/083583 A1**

(51) International Patent Classification<sup>7</sup>: **G03G 15/01**

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(21) International Application Number: **PCT/JP03/03617**

(22) International Filing Date: **25 March 2003 (25.03.2003)**

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(25) Filing Language: **English**

(81) Designated States (*national*): **CN, IN, KR, RU, US.**

(26) Publication Language: **English**

(84) Designated States (*regional*): European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR).

(30) Priority Data:  
2002-091229 28 March 2002 (28.03.2002) **JP**

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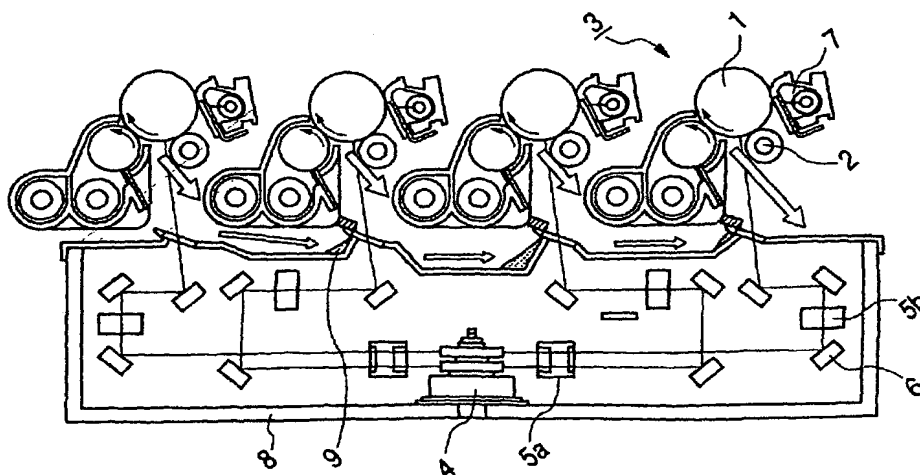
**Published:**  
— with international search report

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: **COLOUR IMAGE FORMING APPARATUS**



(57) Abstract: An image forming apparatus includes a plurality of image forming portions, each of which has a photosensitive member (1) and a developing device (3) for developing an electrostatic image on the photosensitive member (1), and an exposure unit disposed beneath the image forming portions for exposing the plurality of photosensitive members (1). The exposure unit has a frame member (8) that accommodates an optical member. The frame member (8) includes an upper frame portion (10) opposed to the image forming portions. The upper frame portion has a plurality of recessed portions (9) corresponding to the image forming portions respectively.

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## DESCRIPTION

## IMAGE FORMING APPARATUS

## 5 TECHNICAL FIELD

The present invention relates to an image forming apparatus such as a copying machine or a printer that uses an electrophotographic process, and particularly relates to a full color image forming apparatus that has a plurality of image forming portions.

## BACKGROUND ART

Recently, so-called tandem type image forming apparatus having a plurality of image forming portions have been put into practical use in order to increase printing speed.

Figs. 5 to 7 show an example of such a tandem type full color image forming apparatus, which constitutes a background of the present invention.

Fig. 5 is a cross sectional view of the apparatus. The apparatus shown in Fig. 5 is provided with photosensitive drums 20 for respective colors of yellow, magenta, cyan and black. Each photosensitive drum 20 is composed of an electrically conductive member coated with a photosensitive layer, on which an electrostatic latent image is to be formed by a

laser beam emitted from a scanning type optical device. Reference numeral 21 designates the scanning type optical device that emits a laser beam based on image information sent from an image reading apparatus or a personal computer etc. (none of which is shown in the drawings), reference numeral 22 designates a developing device for forming a toner image on the photosensitive drum with triboelectrically charged toner, reference numeral 23 designates an intermediate transfer belt for transferring the toner image on the photosensitive drum onto a transferring sheet, reference numeral 24 designates a feed cassette that accommodates paper sheets on which toner images are to be formed, reference numeral 25 designates a fixing device for causing the toner image having been transferred on the sheet to adhere to it with heat, and reference numeral 26 designates a delivery tray on which the transferring sheet on which the image has been fixed is to be stacked.

In the following, the image forming process will be described.

A laser beam emitted from the scanning type optical device 21 in accordance with certain image information is radiated onto the photosensitive drum 20, so that an electrostatic latent image is formed on the photosensitive drum 20, which has been charged

by a charger 27. Then in the developing device 22, triboelectrically charged toner is applied to the electrostatic latent image, so that a toner image is formed on the photosensitive drum. The toner image  
5 is transferred from the surface of the photosensitive drum onto the intermediate transfer belt 23. The toner image is then further transferred from the intermediate transfer belt 23 onto a paper sheet having been transported from the feed cassette 24  
10 provided in the lower portion of the apparatus main body. Thus, an image is formed on the paper sheet. The image formed on the paper sheet is fixed (i.e. subject to toner fixing) by the fixing device 25, and the sheet is delivered to be stacked onto the  
15 delivery tray.

Fig. 6 is a diagrammatic sketch showing an image forming portion that constitutes a part of the image forming apparatus shown in Fig. 5. The scanning type optical device shown in Fig. 6 forms an  
20 electrostatic latent image on the photosensitive drum by means of a polygon mirror 29 for deflecting the laser beam, which is emitted based on image information, in a scanning manner, f $\theta$  lenses 30a and 30b for enabling constant speed scanning with the  
25 laser beam and for imaging the laser beam as a spot on the photosensitive drum, and a turn-back mirror 31 for reflecting the beam toward a predetermined

direction. The scanning type optical device is vulnerable to dust and soil, and if some part in the optical path of the laser beam is soiled or contaminated, problems such as an image defect at the portion of an image that corresponds to the soil or insufficiency in toner at the portion of the image. In view of such problems, moltopren (trademark) has been used to provide a sealing between an optics case 33 that accommodates optical parts and a top lid 34 as a countermeasure against entrance of dust. On the other hand, with the downsizing of the image forming apparatus main body, the location of the scanning type optical device has been made closer to the photosensitive drum. In addition, in the apparatus of this example, constituent parts are so arranged that the scanning type optical device is disposed below the drums in order to facilitate maintenance of portions in the circumference of the photosensitive members.

20           However, in the case in which the laser beams are radiated from beneath the photosensitive drums or in the case in which the laser beams are radiated from positions close to the photosensitive drums, toner scatters or drops from the developing device, 25 the photosensitive drums or a cleaner etc. in the directions indicated by arrows in Fig. 6, as the apparatus is used.

In view of this, it is necessary to provide dust-proof glass plates 32 at laser beam emitting portions, as shown in Fig. 7, in order to prevent entrance of dust into the interior of the optics case and to prevent contamination of the optical parts.

However, in the image forming apparatus in which the optics case is disposed beneath the apparatus as described above, no countermeasure against contamination of the dust-proof glass plate 32 with dust or toner has been taken, though contamination of the optical elements accommodated in the optics case with dropping toner can be prevented from occurring. Therefore, as shown in Fig. 7, falling toner would slip down on the top surface of the optics case to eventually contaminate the surface of the dust-proof glass plate 32 over time. Such contamination would block the laser beam partially to prevent formation of the electrostatic latent image on the photosensitive drum, which would result in generation of a defective image.

#### DISCLOSURE OF THE INVENTION

An object of the present invention is to provide an image forming apparatus in which an exposure unit is disposed beneath a photosensitive member.

It is another object of the invention to

provide an image forming apparatus in which image exposure is not affected by toner even if toner scattering occurs.

It is further object of the present invention  
5 to provide an image forming apparatus comprising:

a plurality of image forming portions, each image forming portion having a photosensitive member and a developing device for developing an electrostatic image on the photosensitive member; and

10 an exposure unit disposed beneath the image forming portions for exposing the plurality of photosensitive members, the exposure unit having a frame member that accommodates an optical member,

wherein the frame member includes an upper  
15 frame portion opposed to the image forming portions, the upper frame portion having a plurality of recessed portions corresponding to the image forming portions respectively.

Other objects of the present invention will  
20 become apparent from the following detailed descriptions.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing an image  
25 forming apparatus according to a first embodiment of the present invention.

Fig. 2 is a schematic diagram showing an image

forming portion in the first embodiment.

Fig. 3 is a schematic diagram showing an image forming apparatus according to a second embodiment of the present invention.

5 Fig. 4 is a schematic diagram showing an image forming portion in the second embodiment.

Fig. 5 is a drawing illustrating an image forming apparatus.

10 Fig. 6 is a drawing illustrating an image forming apparatus.

Fig. 7 is a drawing illustrating an image forming apparatus.

#### BEST MODE FOR CARRYING OUT THE INVENTION

15 In the following, preferred embodiments of the present invention will be specifically described for an explanatory purpose. It should be noted, however, the dimensions, materials, shapes and relative arrangements of components described in connection  
20 with these embodiments are not intended to restrict the present invention, except as otherwise stated specifically.

##### (First Embodiment)

25 Fig. 1 shows a scanning type optical device and an image forming portion including photosensitive drums etc. according to a first embodiment of the present invention. In Fig. 1, reference numeral 1

designates a photosensitive drum (i.e. a photosensitive member as an image bearing member) composed of an electrically conductive member coated with a photosensitive layer, reference numeral 2

5 designates a charger for charging the photosensitive drum 1 up to a predetermined electric potential, reference numeral 3 designates a developing device for forming an image with toner on an electrostatic latent image, reference numeral 4 designates a

10 polygon mirror for deflecting an emitted laser beam in a scanning manner, reference numerals 5a and 5b designate  $f\theta$  lenses for enabling constant speed scanning with the laser beam and for imaging the laser beam as a spot on the photosensitive drum,

15 reference numeral 6 designates a turn-back mirror for reflecting the beam toward a predetermined direction, reference numeral 7 designates a cleaner for cleaning toner remaining on the photosensitive drum, and reference numeral 8 designates an optics case (a

20 frame member) that accommodates the optical elements of the scanning type optical device. In addition, what is designated by reference numeral 9 is toner that has scattered or dropped from parts such as the photosensitive drum or the cleaner. The thick arrows

25 in Fig. 1 indicate the directions of fall of toner that drops from the developing device 3, the photosensitive drum 1 and the cleaner 7 etc. The

optical path, which passes through a dust-proof glass plate (or a dust-proof window) 11, of the laser beam incident on the photosensitive drum 1 is arranged outside the space defined between the vertical plane (designated by letter "a") at the open end of the frame of the developing device for covering a developing roller that faces the photosensitive drum and the vertical tangential plane (designated by letter "b") of the charging roller. The toner dropping from parts such as the developing device 3, photosensitive drum 1 and the cleaner 7 falls on an optics case top lid 10 that covers over the optics case 8 of the scanning type optical device that is disposed beneath. The toner having fallen on the optics case top lid 10 gradually accumulates thereon, and eventually slips down on the surface of the optics case top lid 10.

In this embodiment, the optics case top lid 10 is formed in such a shape that the optics case top lid 10 is placed below a plane "c" that includes edges of adjoining dust-proof glass plates 11, so that there is provided toner pool portions (i.e. a recessed portions) 9 that can receive a certain amount of toner that has slipped down. In addition, in order to prevent contamination of the dust-proof glass plates 11 by the scattering of the accumulated toner caused by slight airflow or some mechanical

shock within the apparatus, moltopren 12 is provided at the gaps between the optics case top lid 10 and the upper units such as the developing devices 3 to stop the gaps. With the above-described structure, the dust-proof glass plates 11 are difficult to be contaminated by fallen toner, and therefore image quality would be kept high. In addition, maintenance operations can be omitted or simplified.

(Second Embodiment)

10 In the following, a second embodiment of the invention will be described focusing mainly on features that are different from the first embodiment described above. In the second embodiment, components that have the same structure and function as those in the first embodiment will be designated by the same reference numerals as in the first embodiment and descriptions thereof, which would be redundant, will be omitted.

Fig. 3 shows a scanning type optical device and an image forming portion including photosensitive drums etc. in the second embodiment of the present invention.

On the optics case top lid 10 of the scanning type optical device that is disposed horizontally, a protecting covers 13 is provided in such a manner as to nearly cover each dust-proof glass plate 11, while leaving an area required for allowing irradiation of

a laser beam onto a photosensitive drum 1. The dust-proof glass plate 11 is provided outside the space defined between the vertical plane at the open end of a developing device frame covering a developing  
5 roller that faces the photosensitive drum and the vertical tangential plane of a charging roller. The protecting cover 13 is provided for preventing the dust-proof glass plate 11 from being contaminated by toner dropping from upper structures such as  
10 developing device 3 disposed on the right side of the protecting cover 13 as shown in Fig. 3 and by toner scattering (or flying) in the interior of the apparatus.

As shown in Fig. 4, in the apparatus structure  
15 according to this embodiment, falling or scattering toner is brought by the protecting cover 13 that covers the dust-proof glass plate 11 to a toner pool portion 14 located on the right side of the dust-proof glass plate 11. The protecting cover 13 and  
20 the sloped portion of the toner pool portion 14 of the optics case top lid forms a shape of an unfolded fan, and the dust-proof glass plate 11 is shielded except for an area including the cross section of the light flux of the laser beam. With these features,  
25 it is possible to protect the dust-proof glass plate 11 mostly not only against falling toner but also against scattering or flying toner. With the above-

described structure, the dust-proof glass plate 11 is difficult to be contaminated by fallen toner, and therefore image quality would be kept high. In addition, maintenance operations can be omitted or  
5 simplified.

As described in the foregoing, according to the present invention, the optical path of the laser beam incident on the image bearing member is arranged outside the space in which toner falls, and a  
10 recessed portion that is recessed relative to the dust-proof glass plate is provided at the upper portion of the frame for optical members. With these features, it is possible to prevent the surface of the dust-proof glass plate from being contaminated by  
15 scattering or falling toner that would be generated in the course of operations of the apparatus.

## CLAIMS

1. An image forming apparatus comprising:  
a plurality of image forming portions, each  
image forming portion having a photosensitive member  
5 and a developing device for developing an  
electrostatic image on said photosensitive member  
with toner; and

an exposure unit disposed beneath the image  
forming portions for exposing the plurality of  
10 photosensitive members, said exposure unit having a  
frame member that accommodates an optical member,  
wherein said frame member includes an upper  
frame portion opposed to the image forming portions,  
the upper frame portion having a plurality of  
15 recessed portions corresponding to the image forming  
portions respectively.

2. An image forming apparatus according to  
claim 1, wherein the image forming portions are  
20 arranged along an oblique direction, and the upper  
frame portion is inclined substantially along the  
direction along which the image forming portions are  
arranged.

25 3. An image forming apparatus according to  
claim 1, wherein the upper frame portion has a  
plurality of windows provided in positions different

from the recessed portions, for transmitting image light beams used for exposure of the photosensitive members.

- 5           4. An image forming apparatus according to claim 3, further comprising a cover for preventing toner from falling onto the windows.

**FIG. 1**

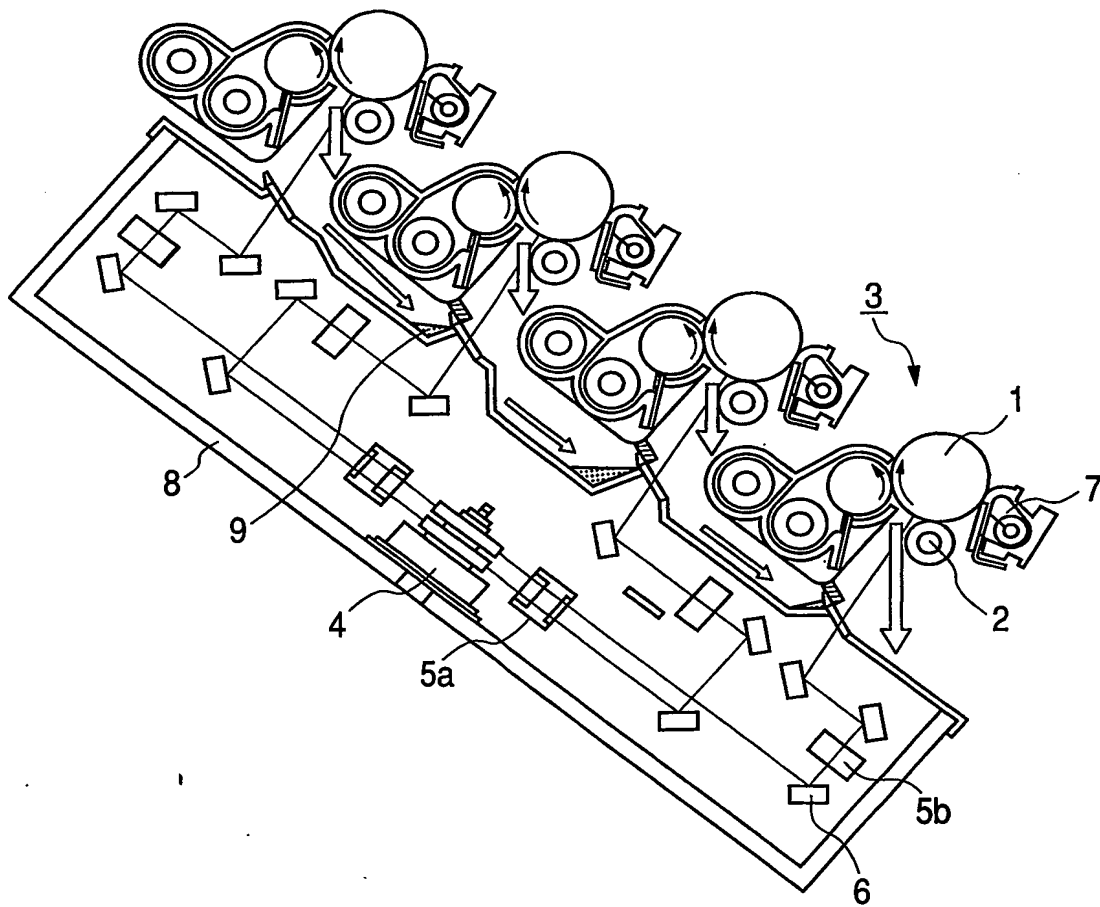
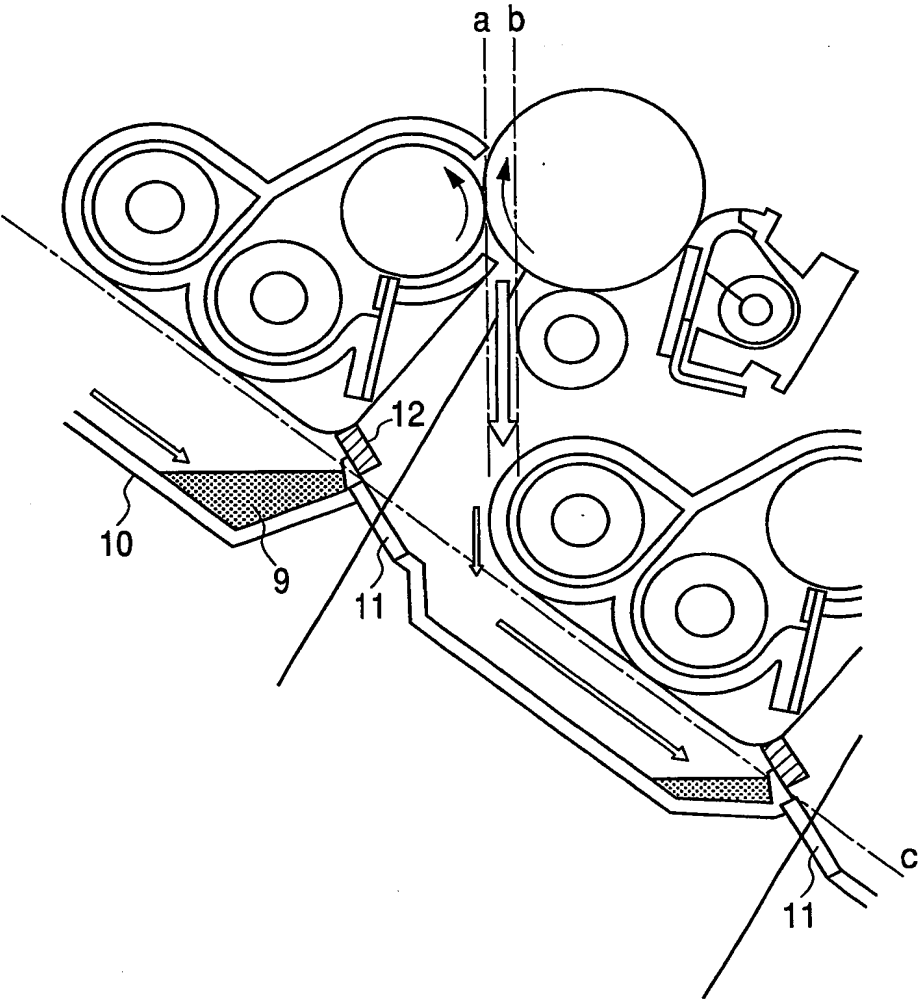
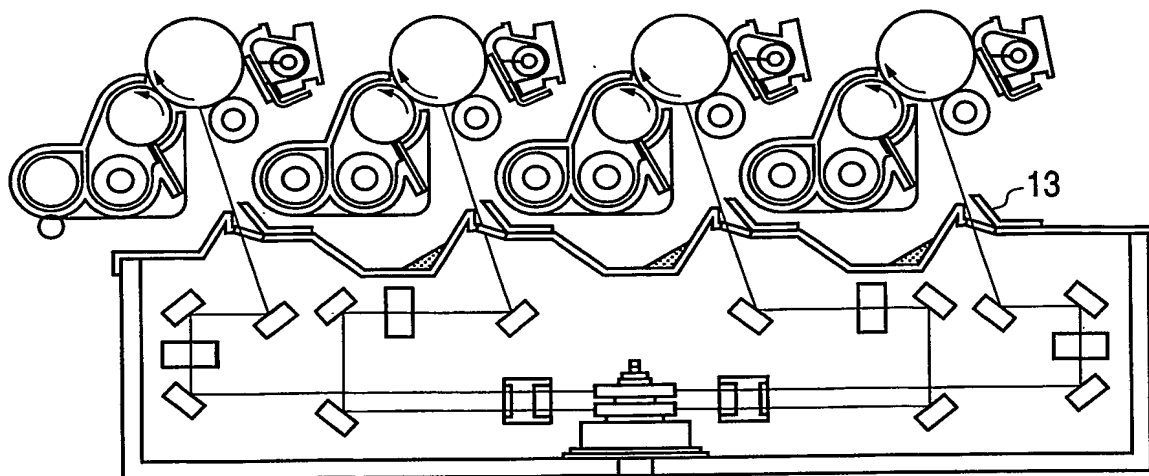


FIG. 2



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**FIG. 3**



**FIG. 4**

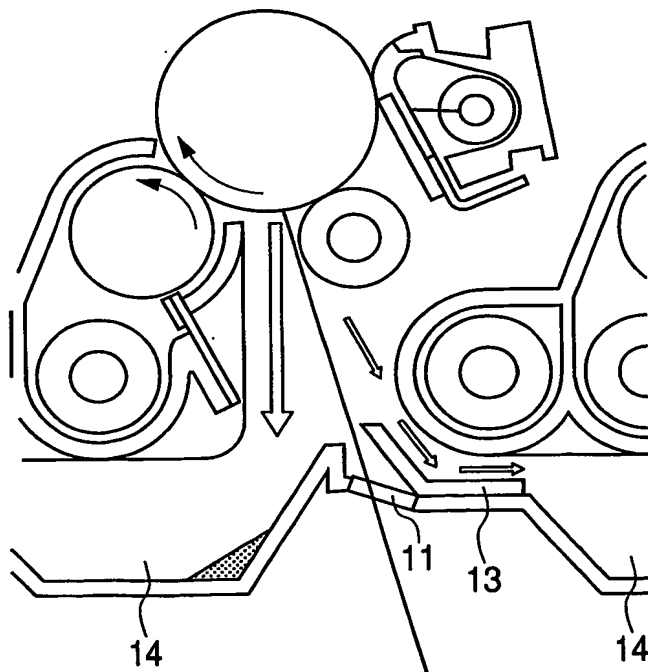
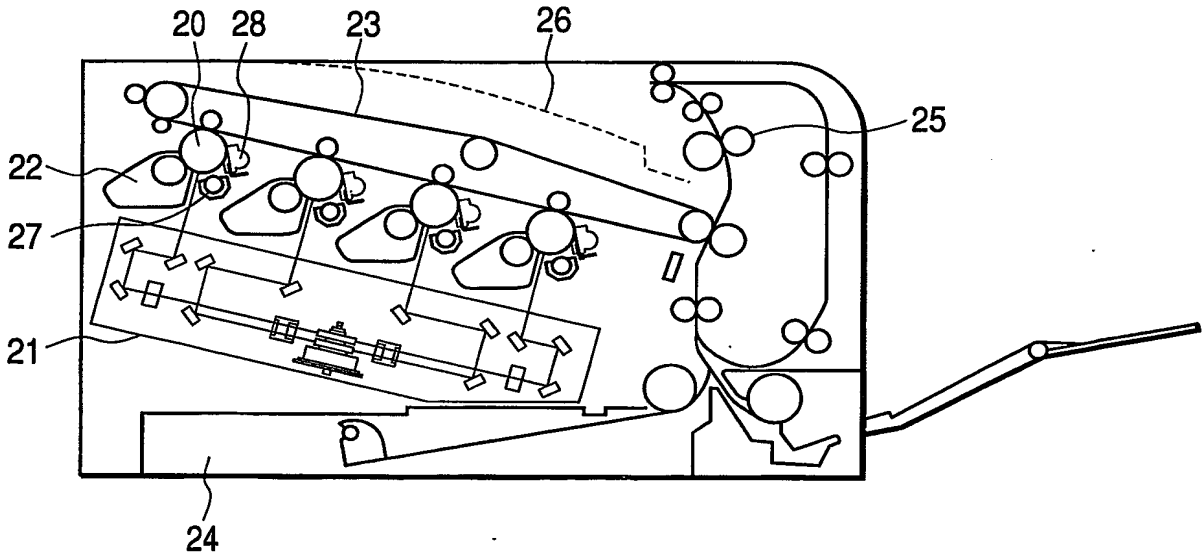


FIG. 5



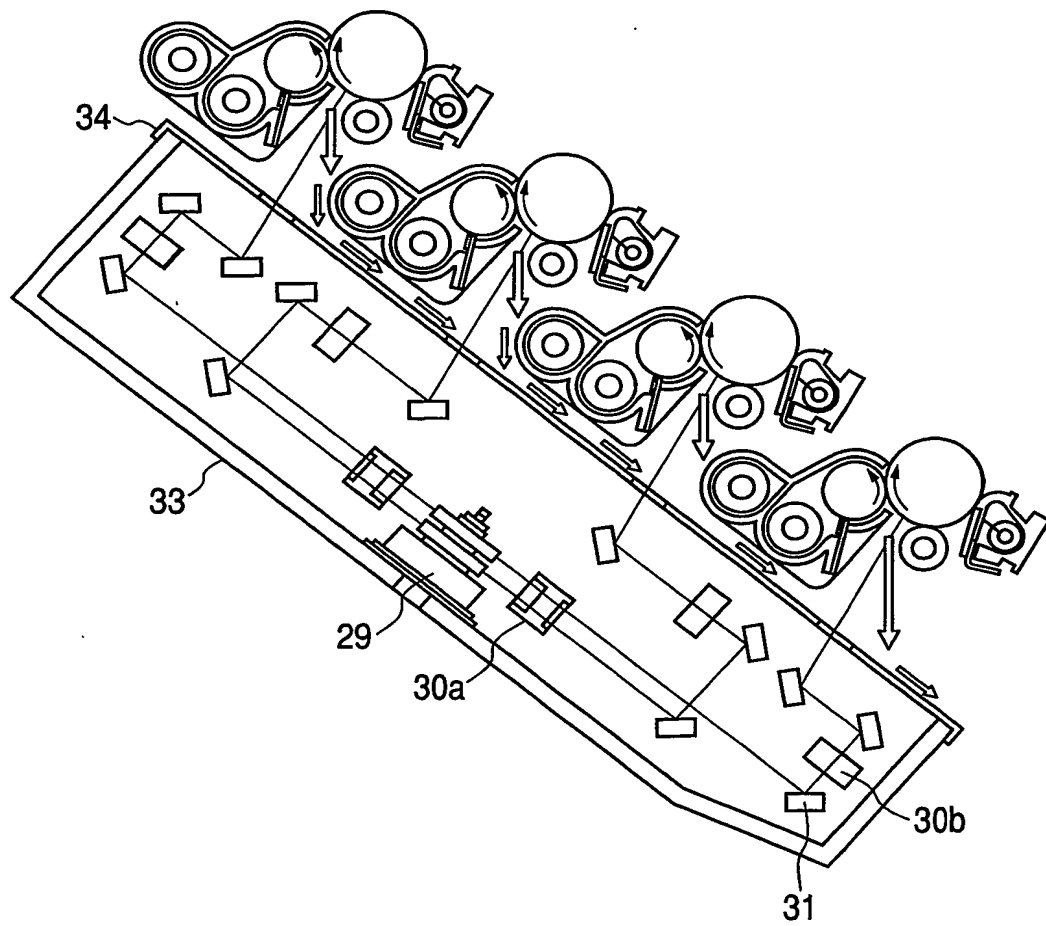
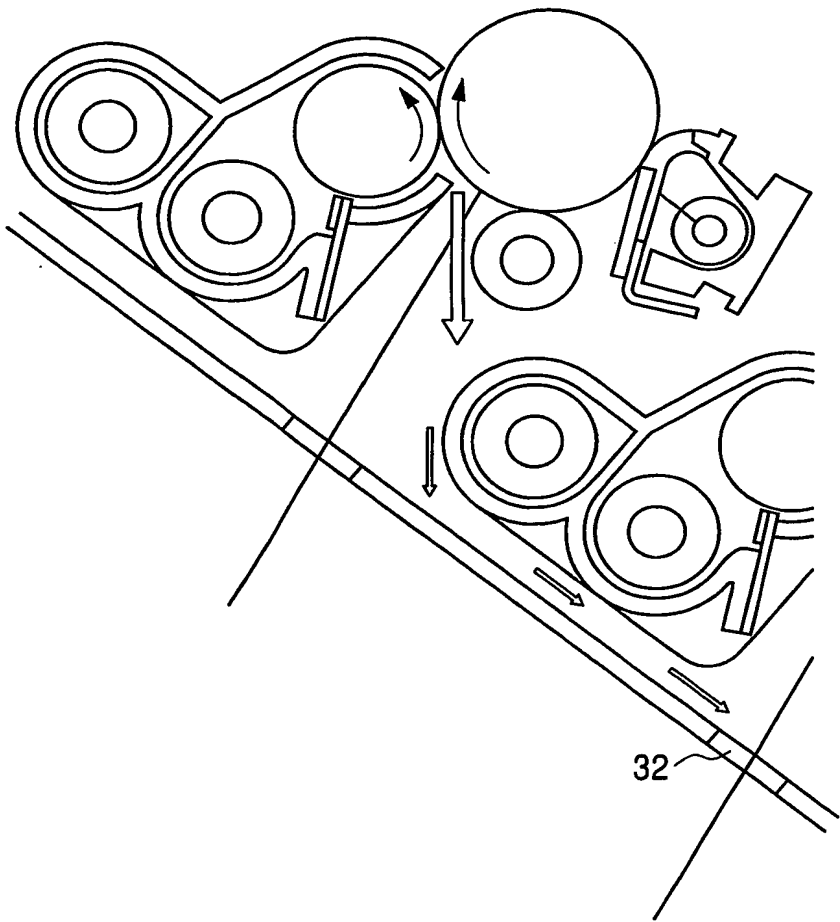
*FIG. 6*

FIG. 7



## INTERNATIONAL SEARCH REPORT

Application No

PCT/JP 03/03617

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G03G15/01

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G03G H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 734 154 A (TOKYO SHIBAURA ELECTRIC CO) 25 September 1996 (1996-09-25) column 5, line 21 - line 41 column 7, line 16 - line 40 column 10, line 56 - column 11, line 4; figure 2	1-4
Y	US 6 271 869 B1 (HAGINOYA YOSHIKI ET AL) 7 August 2001 (2001-08-07) column 7, line 47 - line 65; figure 4	1-4
Y	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 05, 31 May 1996 (1996-05-31) -& JP 08 022174 A (BROTHER IND LTD), 23 January 1996 (1996-01-23) abstract; figure	1-4

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

17 June 2003

Date of mailing of the international search report

30/06/2003

Name and mailing address of the ISA

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JP 03/03617

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